Improved egg quality for increased hatchability and enhanced performance

Decades of skillful breeding and selection have resulted in today's high performance breeders: hens that can produce almost 200 chicks per cycle.

Naturally, for this supreme level of performance, breeders need optimum nutrition, not only for maintaining an efficient metabolism, but also for the development of their eggs.

by Isaac Bittar, Regional Vitamins Manager, Latin America, and Jefferson Lecznieski, Technical Manager, Brazil.
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The eggs they produce have to be fertile and offer a safe, secure environment for the next generation – embodied in a vital, fast-growing embryo with top hatchability, livability and massive growth potential.

Every component involved – starting with the shell, then the embryo, and ending with the growing chick – ultimately depends on the quality of the breeder feed and its ingredients.

Crucial shell strength

Shell problems in the breeding flock include cracks, breakage and unsuitable shapes. Shell faults are influenced by layer breeding, but also by the age of the hen. This is because a hen deposits approximately the same amount of calcium in every egg it lays over a cycle.

As a hen ages, its eggs become larger and this means the proportion of calcium per egg is less. The season of the year can affect shell strength too. First of all, high ambient temperatures (over 25°C) can depress breeder appetite and result in calcium intake being less than optimal.

In addition, rapid breathing by birds in very warm weather causes a condition called respiratory alkalosis, where the blood becomes more alkaline, which leads to a series of metabolic reactions that reduces calcium supply for eggshell production and increases incidence of soft-shelled eggs.

Nutrition is crucial for shell strength and a major ingredient is calcium. For example, a chicken egg comprises up to 97% calcium carbonate.

Around 30-40% of the calcium in shells comes from the hen's medullary bone, formed at the end of growth and start of production.

Keeping this bone healthy throughout the entire reproductive phase is crucial and this relies on adequate intake of calcium, phosphorous and vitamin D3.

Calcium balance

Around 4g of calcium daily intake per layer is required for good shell quality. During shell formation, calcium is drawn from both feed and from the hen's body reserves, including the bones. To ensure skeletal integrity, it is therefore important to have enough calcium available in the hen's ration.

Each egg shell only contains around 20mg of phosphorous (egg content, on the other hand, has about six times this amount).

Any imbalance to the feed calcium: phosphorous ratio impairs absorption of calcium and or phosphorus, and of other important dietary minerals.

Table 1. Egg composition by age of layers (Bertechini et al. 2005).

	Egg composition (%)		
Age (weeks)	Yolk	Albumin	Shell
30	24.0	65.0	10.0
60	29.5	61.0	9.5
74	30.1	60.8	9.1

The carbonate source, as well as the type of limestone and grinding, is critical. At least 50% of total calcium carbonate source should be in particulate form of around 5mm.

Vitamin D3 is also vital for calcium absorption and mobilisation by the breeder layer, as well as for phosphorous utilisation. The vitamin D3 function is related to its metabolite 25 hydroxy D3 in plasma. Including this metabolite directly as dietary ingredient in feed provides a very effective way of optimising calcium and phosphorus absorption and utilisation, thus maintaining skeletal integrity of the breeder layer and increasing the number of settable eggs produced.

Improved hatchability

In a recent paper published by the University of Alberta in Canada (Saunders-Blades and Korver, 2014) 29-week breeders on a diet supplemented with 69µg/kg of Hy-D (a commercially available form of 25-OH-D3 – a metabolite and main circulating form of vitamin D3 – by DSM Nutritional Products) produced eggs with a higher percentage of shell (9.86 vs. 9.68%) when compared with breeders receiving conventional vitamin D3 as a dietary ingredient.

This increase in shell content substantially

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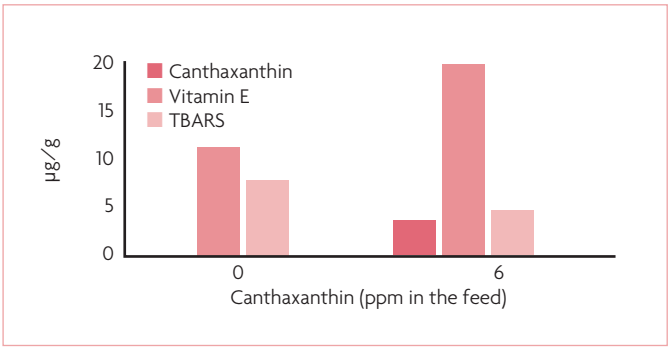

Fig. 1. Levels of canthaxanthin, vitamin E and TBARS in the liver of chicks from breeders fed with MaxiChick.

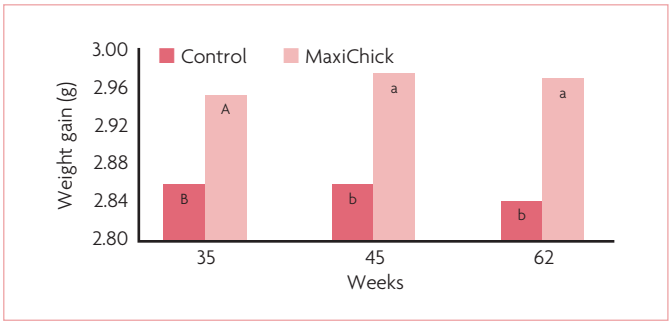

Fig. 2. Weight gain of the progeny of broiler breeders at 35, 45 or 63 weeks of age as affected by the ingestion of MaxiChick by their mothers compared with control hens (Adapted from Araujo and Araujo, 2013).

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reduced early mortality of embryos (4.37 vs. 6.22%) due to the better protection given by a good shell.

A second advantage of 25-OH-D3 is that its metabolism helps the embryo incorporate egg shell calcium into its skeleton, increasing bone strength of the future chick and ensuring easier hatching. Thus shell quality has a direct effect on hatchability and chick viability.

It is also greatly affected by the age of the hens in the breeding flock.

Reducing embryo mortality

The yolk and albumen provide essential nutrients for the developing embryo. The albumen actually does much more than this, as it also protects the embryo from any bacteria that might get into the egg.

To be effective in this role, the albumen has a high pH content and contains very active antimicrobial proteins. However, these properties would also harm the embryo should it come in direct contact with the albumen.

To prevent this, the embryo is protected by the vitelline sac, formed after the first 72 hours of incubation and comprising a protein membrane strengthened by disulphur bonds. Keeping this protective membrane intact throughout embryo development in the egg is crucial to its survival.

The membrane must not become too rigid and therefore fragile. This can occur when the disulphur bonds oxidise. Boosting presence of antioxidants within the egg supports maintenance of a strong, supple vitelline membrane, and so helps ensure embryo survival.

Carotenoids are powerful antioxidants normally available in layer diets and present in the egg yolk, giving this a typical shade of yellow to red.

In a recent paper published by Hamelin et al. (2015), it is shown that eggs from hens given feed supplemented with 6ppm of a nature identical form of the carotenoid canthaxanthin (CXN) have stronger vitelline membranes.

This could help to explain the lower embryo mortality found in eggs where layers are fed diets supplemented with CXN (see Table 2).

Rosa et al. (2012) found eggs from hens on a diet with 6ppm CXN supplementation also had lower embryo mortality during the first two days of incubation. The eggs had a higher antioxidant capacity due to the antioxidant activity of the carotenoid canthaxanthin.

Further work by Surai (2012) showed the high deposition rate of CXN, supporting its antioxidant role in eggs where, together with vitamin E, it is the only antioxidant present in the yolk.

Two advantages combined

When the feed supplements canthaxanthin (Carophyll) and Hy-D are brought together in a single product (MaxiChick by DSM) the advantages for optimising breeder production increase, according to investigations in the USA by Araujo in 2012.

These showed that adding MaxiChick to the layer diet increased chicks per hen

Table 2. Enhanced embryo performance where layer feed is supplemented with 6ppm canthaxanthin (CXN) (Adapted from Rosa 2012).

Variable	Control	Canthaxanthin	Prob.
Hatchability total (%)	83.03	86.22	0.001
Total embryonic mortality (%)	5.46	3.72	0.0029
Embryonic mortality first 48 hours (%)	1.80	1.04	0.0083
Embryonic mortality 3-7 days of incubation (%)	0.89	0.66	0.2225

performance through improving fertility and hatchability and giving more settable eggs.

Better progeny performance

The advantages of the above-mentioned supplementation do not stop at more chicks per hen, however. We now know that layer nutrition optimised in this way also boosts subsequent performance of progeny.

Vitamin E is the most important nutrient to improve immunity and health status in the bird, besides its role in development and growth. So the higher the vitamin E content, the better. In this way, the use of canthaxanthin in the breeder diet helps to improve the liver vitamin E content two fold (Fig. 1). For instance, in an experiment carried out at the University of Sao Paulo it was shown that the progeny of breeders fed MaxiChick grow faster, return better feed conversion efficiency and produce a higher yield of breast meat (Fig. 2).

Thus, the comprehensive gains available from this supplement start with enhanced egg quality, in terms of optimum shell strength and nutrient content, and goes on to include healthy and vital embryo development with better hatchability.

The benefits then conclude with improved progeny health and performance, resulting in a combined advantage for improved bird health, welfare and more profitable production.

Conclusion

It is possible to improve the number of chicks produced by improving hatchability, while at the same time improving the quality of those chicks.

Ensuring the best quality eggs are produced via ensuring optimised dietary nutrition is included in feed allows for an increased number of day old chicks and therefore helps deliver more profitability for the chick producer, the broiler and ultimately the meat company, resulting in a benefit for all parties. ■